



Columbia Environmental
Research Center

River Corridor Habitat Dynamics

Geomorphologists at Work, Geomorphologists at Play:

Geomorphic Research and Resource Management in National Parks

**Robert B. Jacobson
U.S. Geological Survey
Columbia, Missouri**

**U.S. Department of Interior
U.S. Geological Survey**

rjacobson@usgs.gov

Work and Play

Play: The Handmaiden of Work

Wolman, M.G., 1995, Earth Surface Processes and Landforms, v. 20, p. 585-591

- Play as exploration of the fundamental, theoretical issues underlying applied Geomorphology
- Play as a social dynamic: how we work (and play) together





Got Geomorphology?

- ***Restricted definition:***
 - Study of the shape of the earth
- ***Extended definition:***
 - Study of the structure, processes, and history that have shaped and continue to shape the surface of the earth (and other planetary bodies)

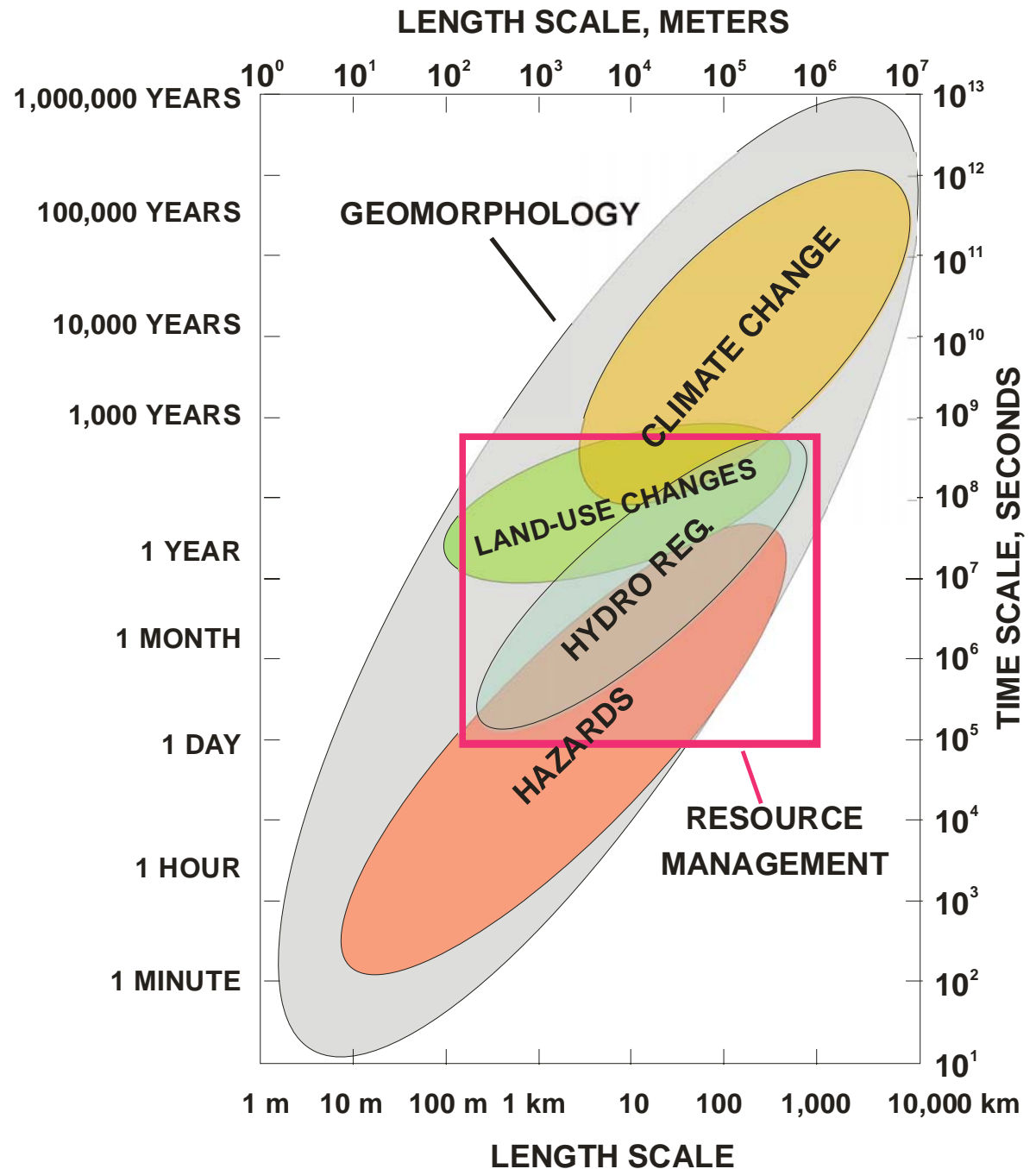
Scope of Geomorphology

- ***Inherently interdisciplinary:***

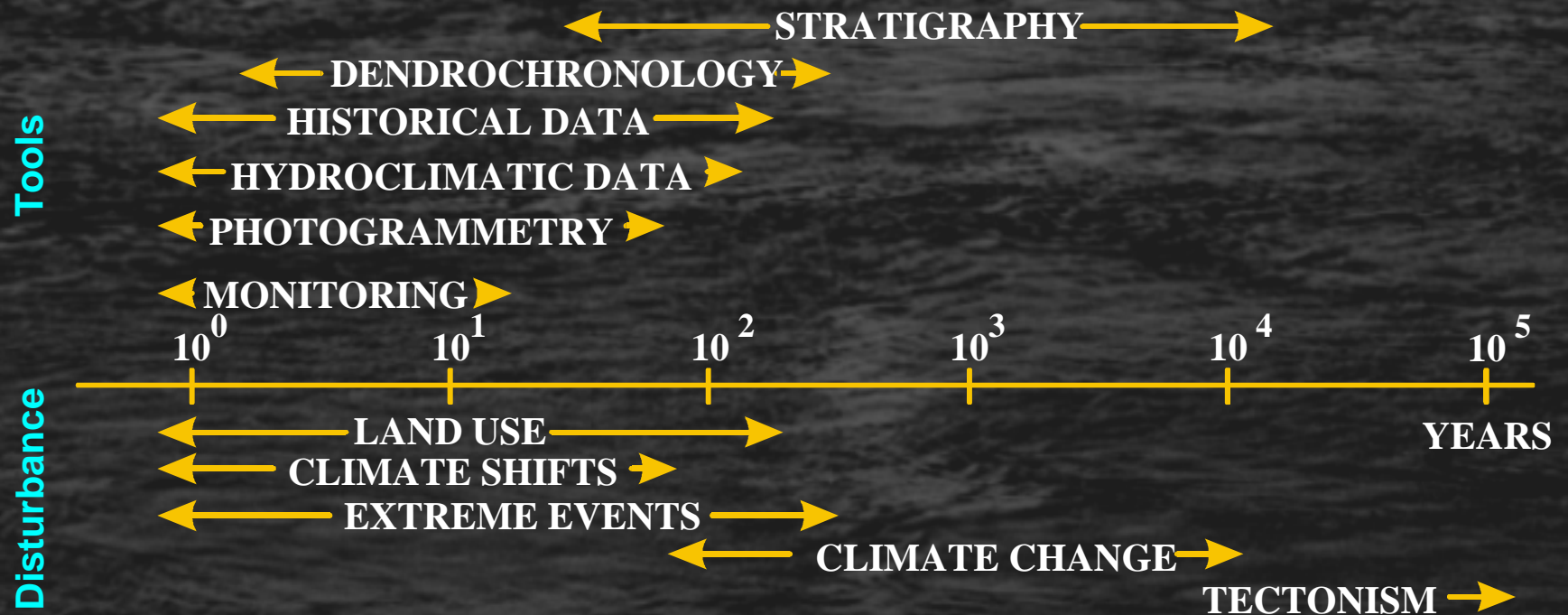
- ***Geology***
- ***Hydrology***
- ***Hydraulics***
- ***Sediment Transport***
- ***Soil Mechanics***
- ***Geochemistry***
- ***Geophysics***
- ***Climatology***
- ***Pedology***
- ***Ecology***
- ***Civil / Environmental Engineering***
- ***Geographic Info. Science***
- ***Social Sciences***
- ***...***

Time, Space, Geomorphology

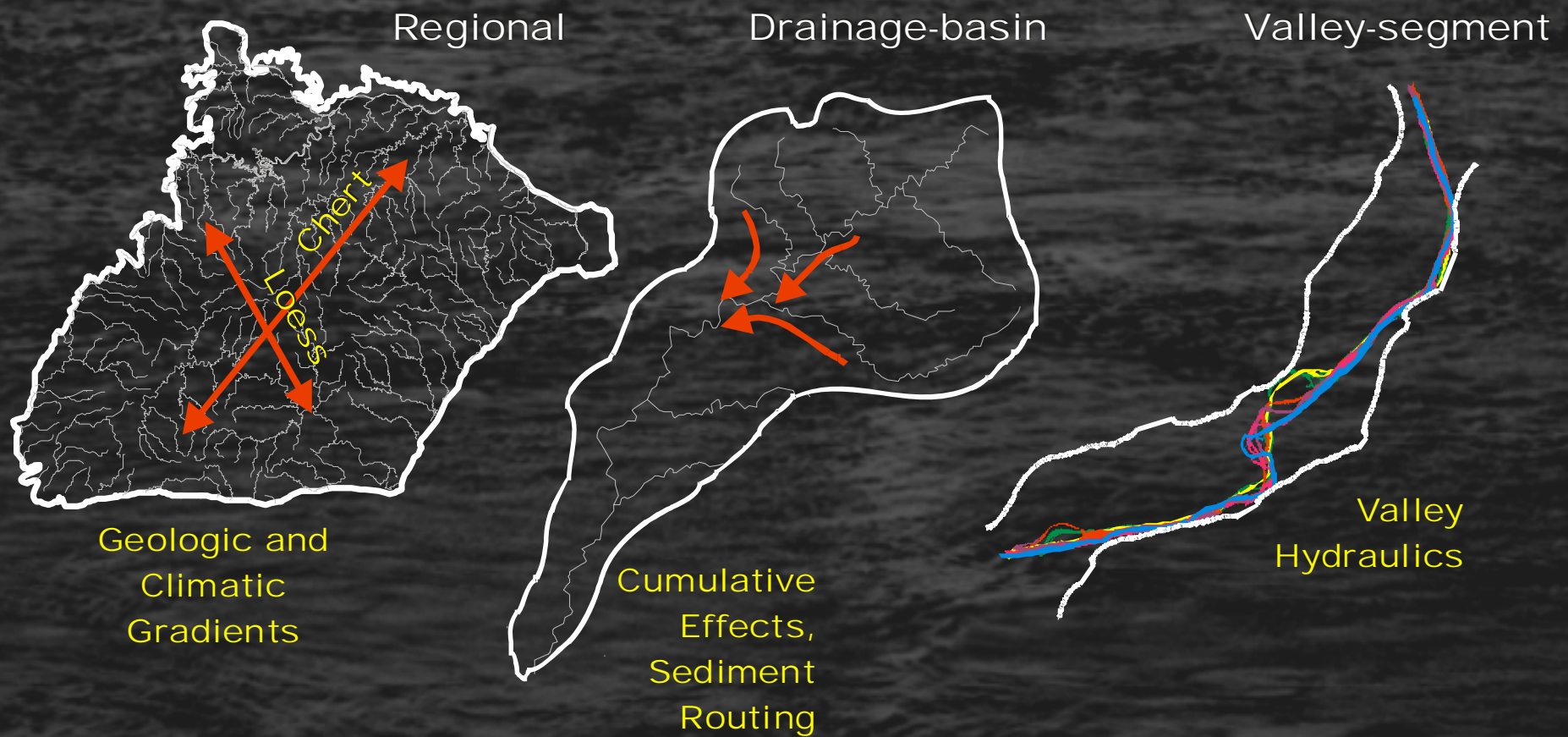
- ***Time scale***
- ***Spatial scale***
- ***Integration of scales and disciplines***



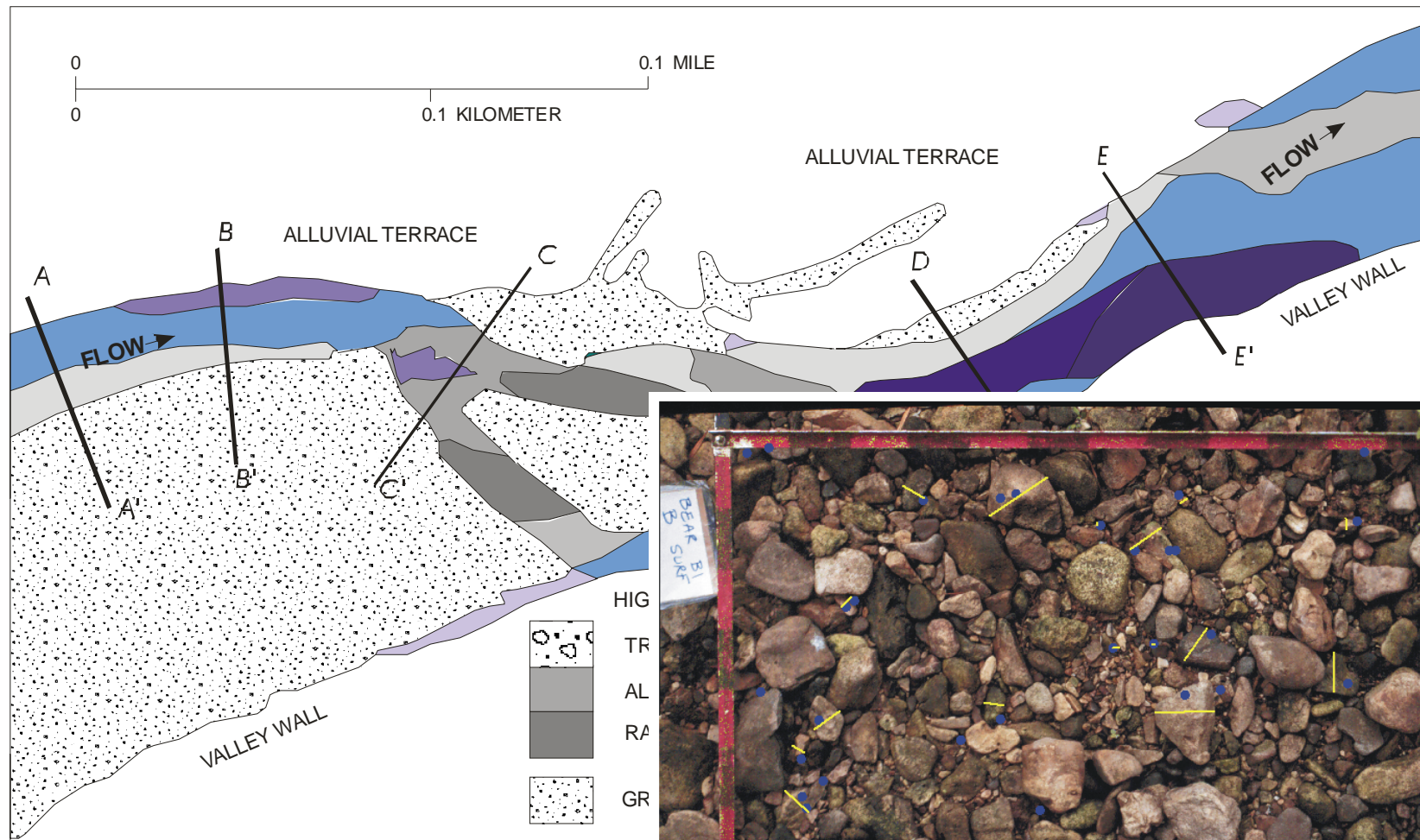
Timescales of Fluvial Geomorphology And Data Resources



Spatial Scales: Ecoregion to Valley Segment



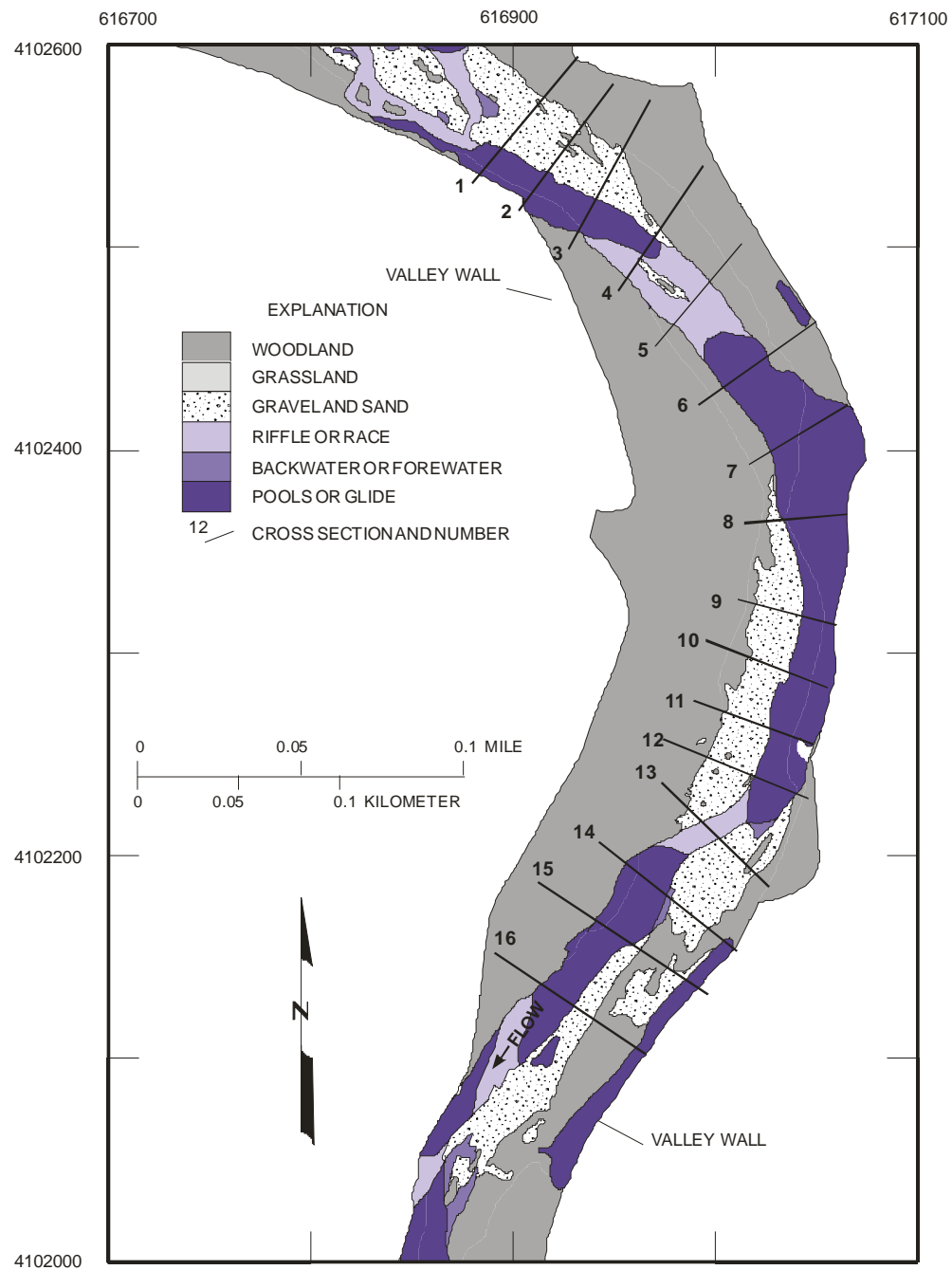
Spatial Scales: Channel Units to Particles



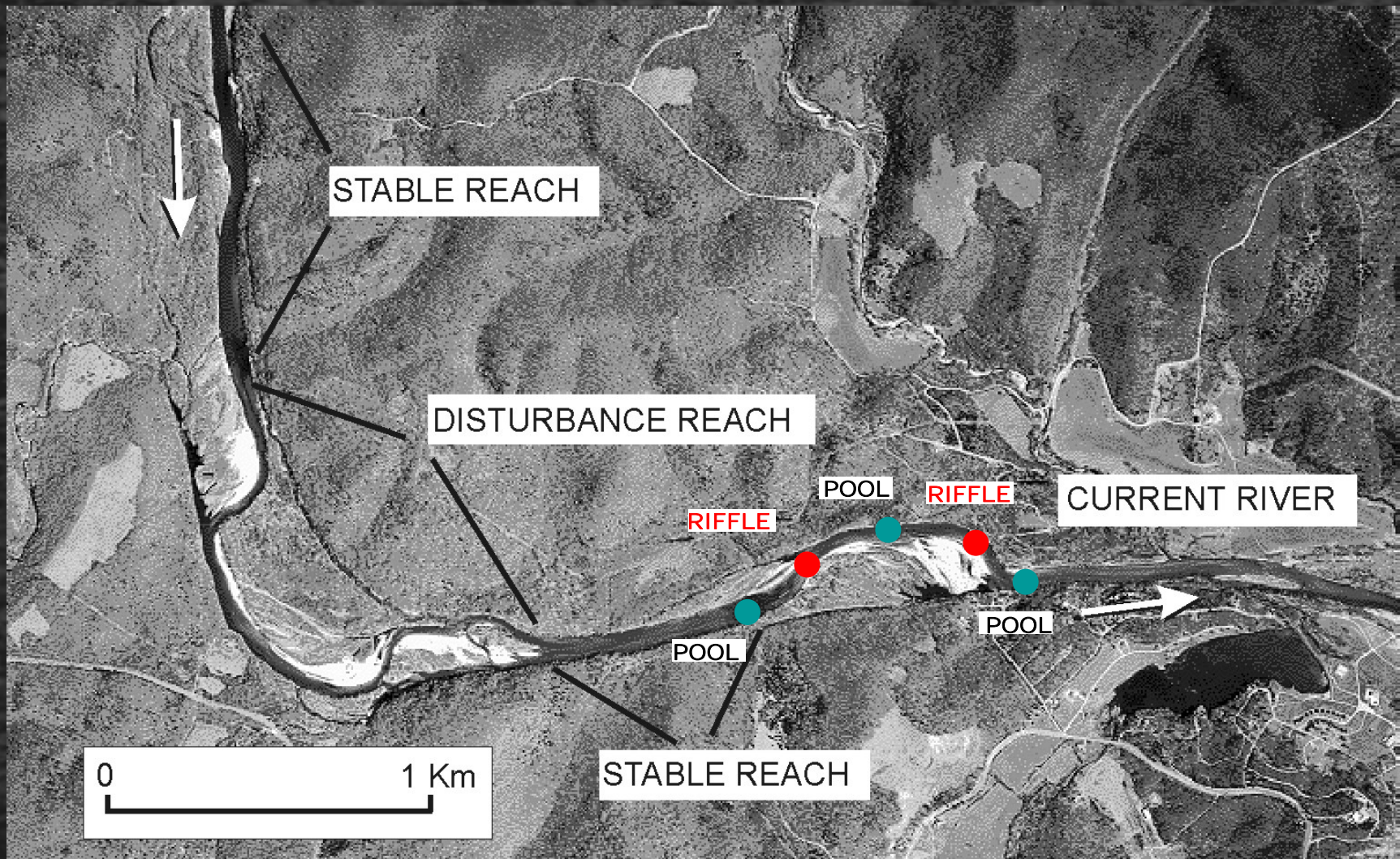
Space

- **Work:** *Geomorphic channel unit classification to stratify biological sampling designs*
- **Play:** *Fundamentals of hydraulic instabilities and fluvial form*

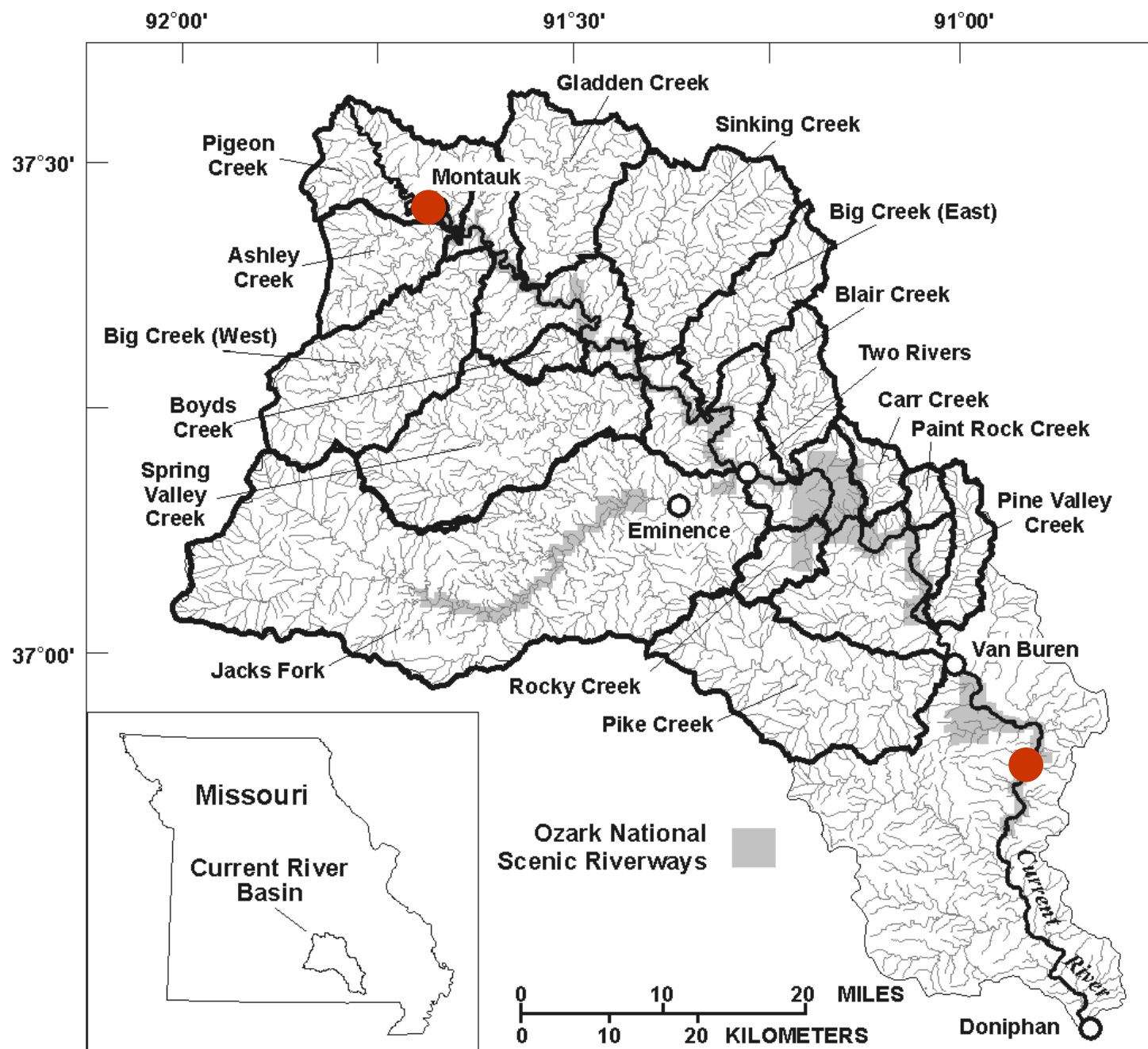
Channel Unit Classification



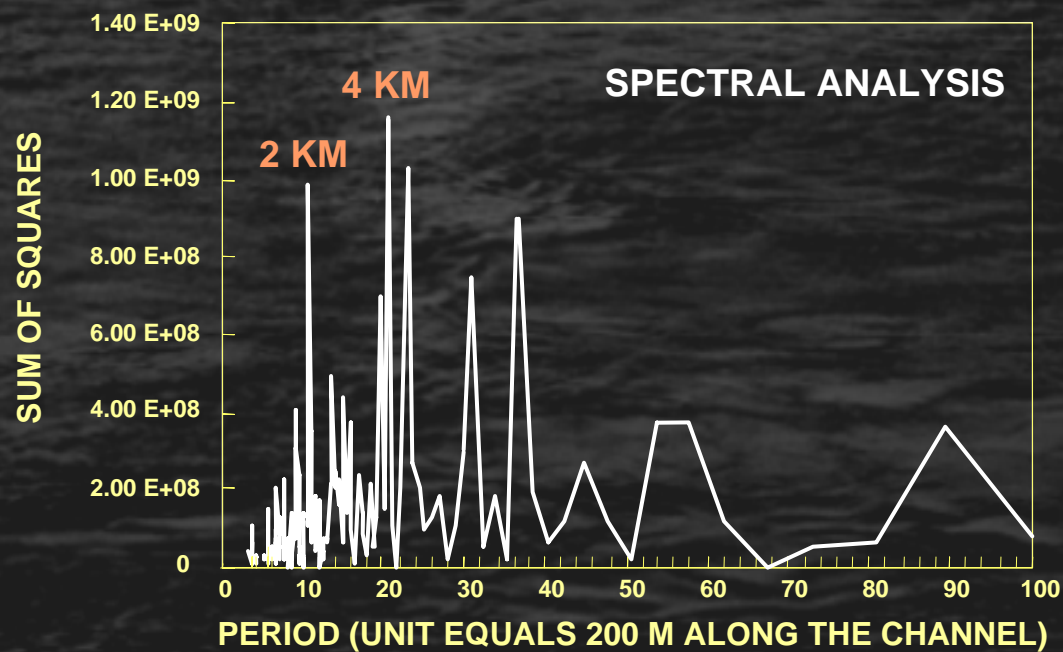
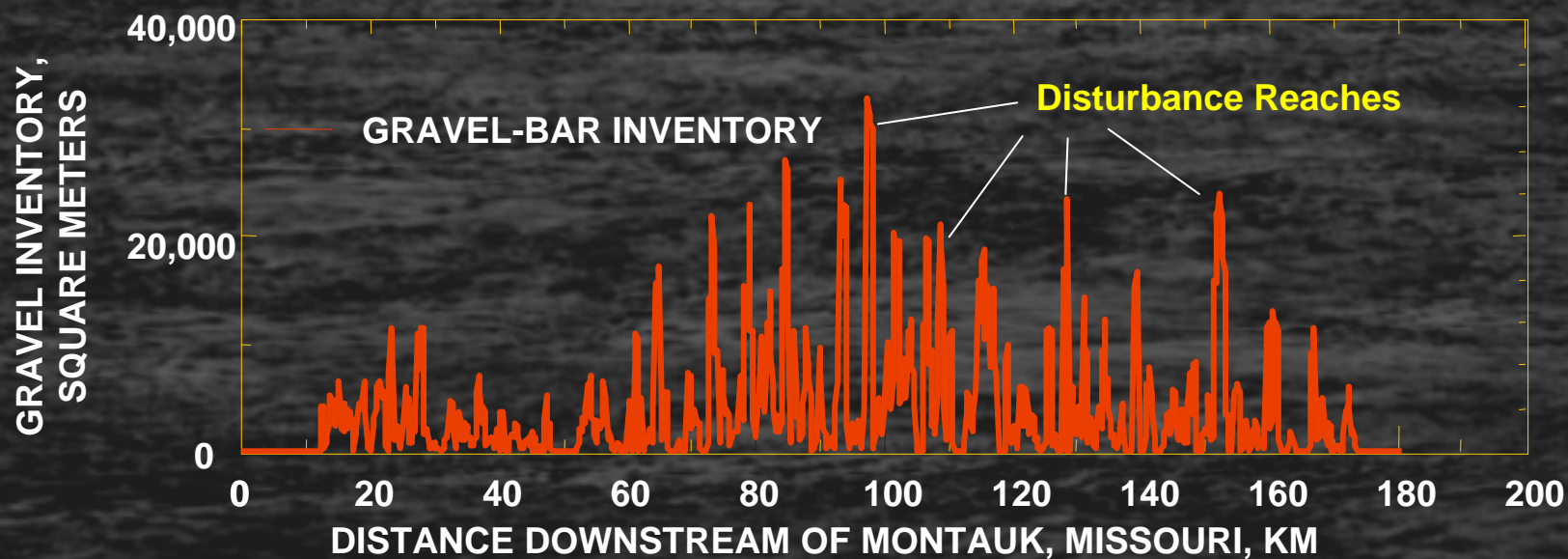
Architecture of Ozarks Rivers



Current River, Ozark National Scenic Riverways



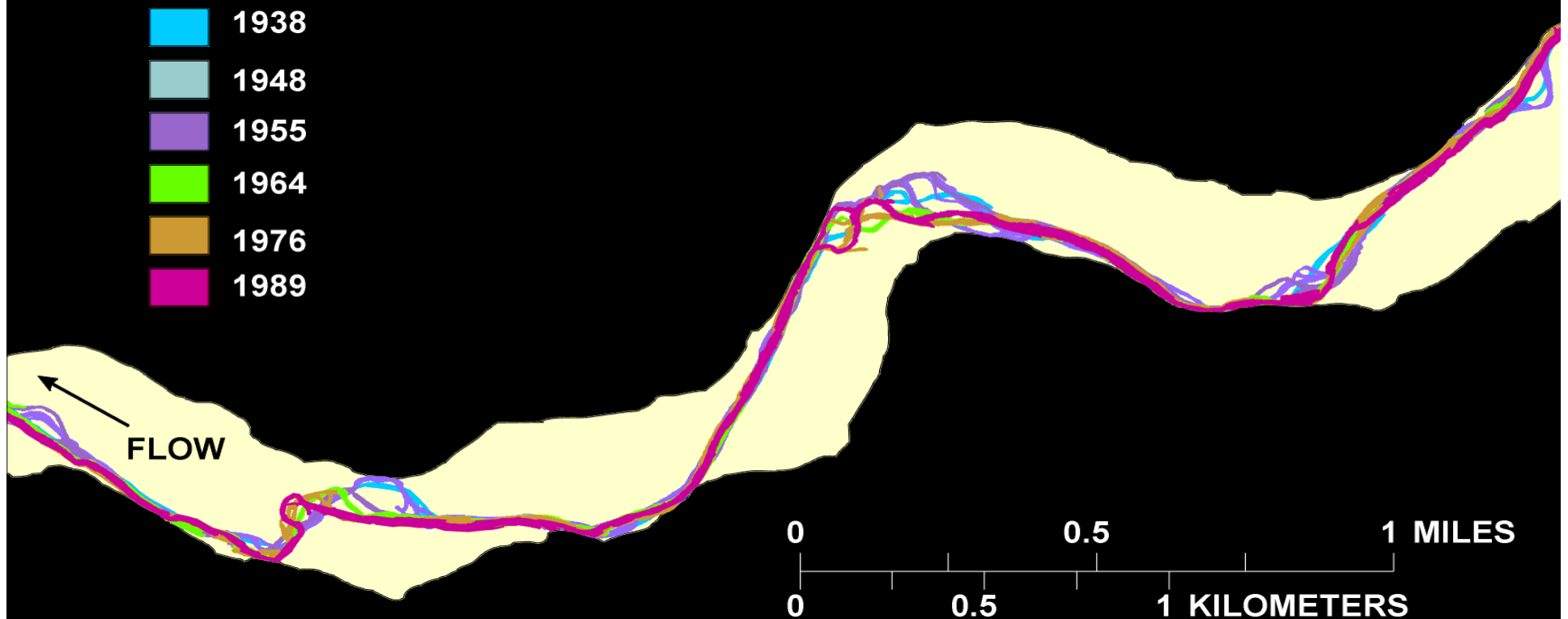
Architecture of Ozarks Rivers



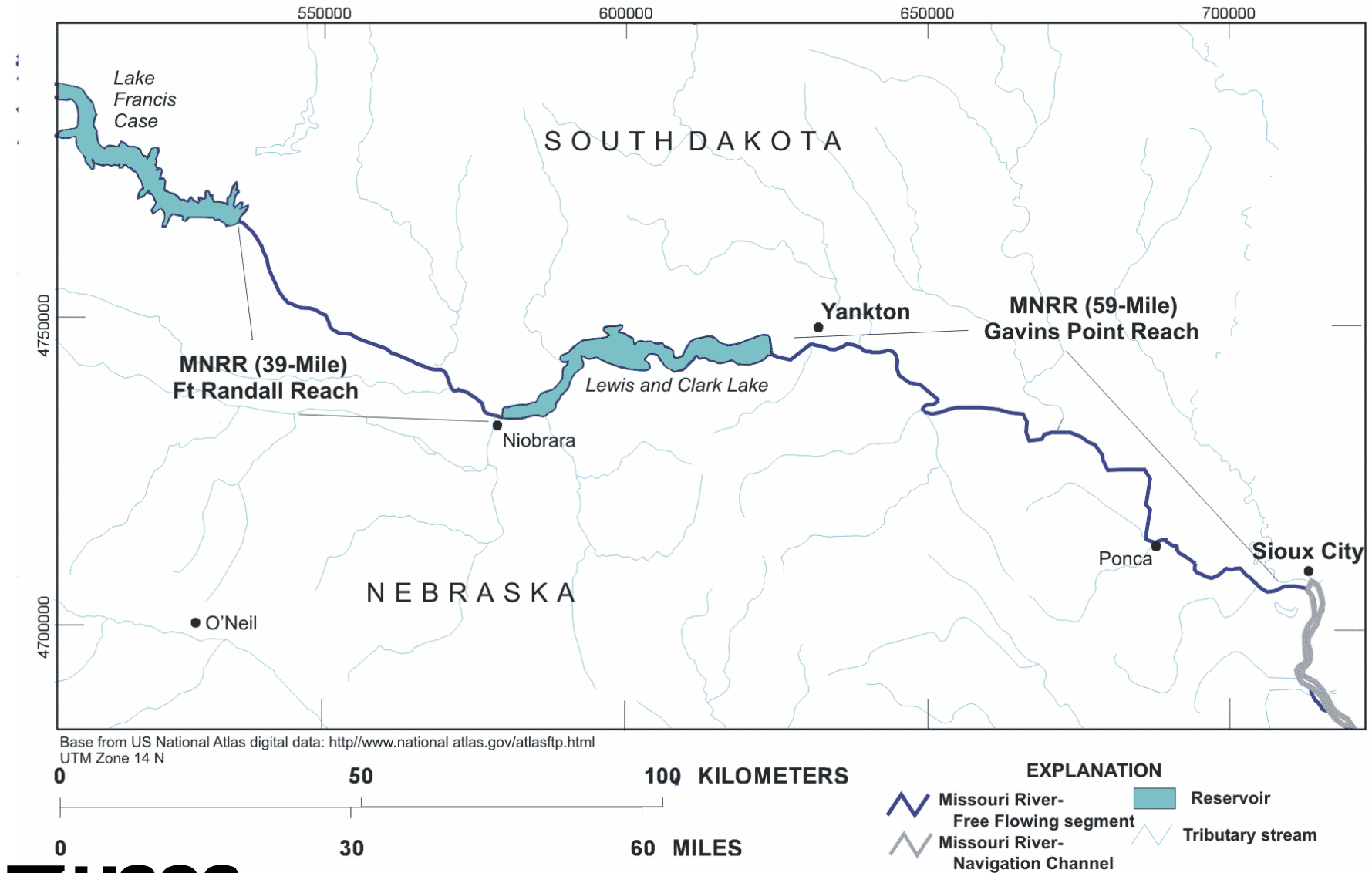
Architecture of Ozarks Rivers

Discrete and persistent disturbed and stable reaches

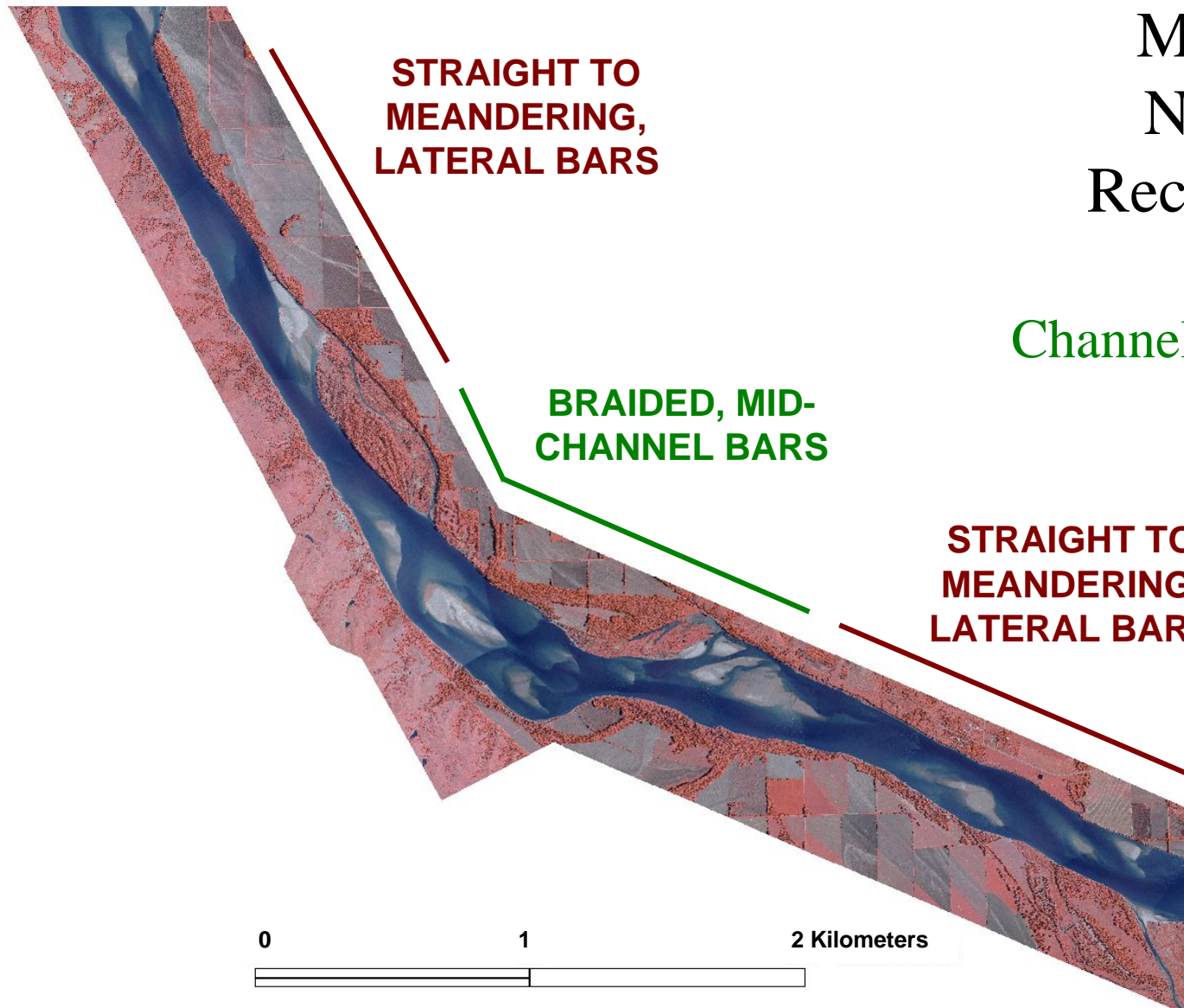
Not uniform rate of energy dissipation



Architecture of the Missouri National Recreation River

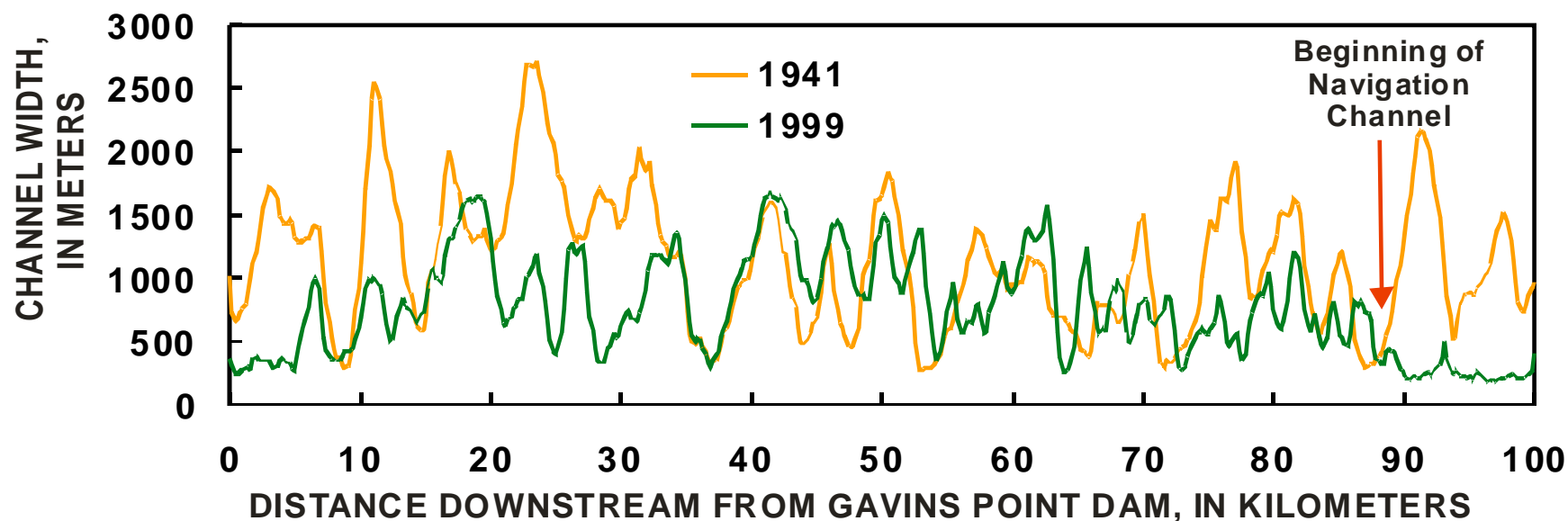


Missouri
National
Recreation
River
Channel Pattern
Classes



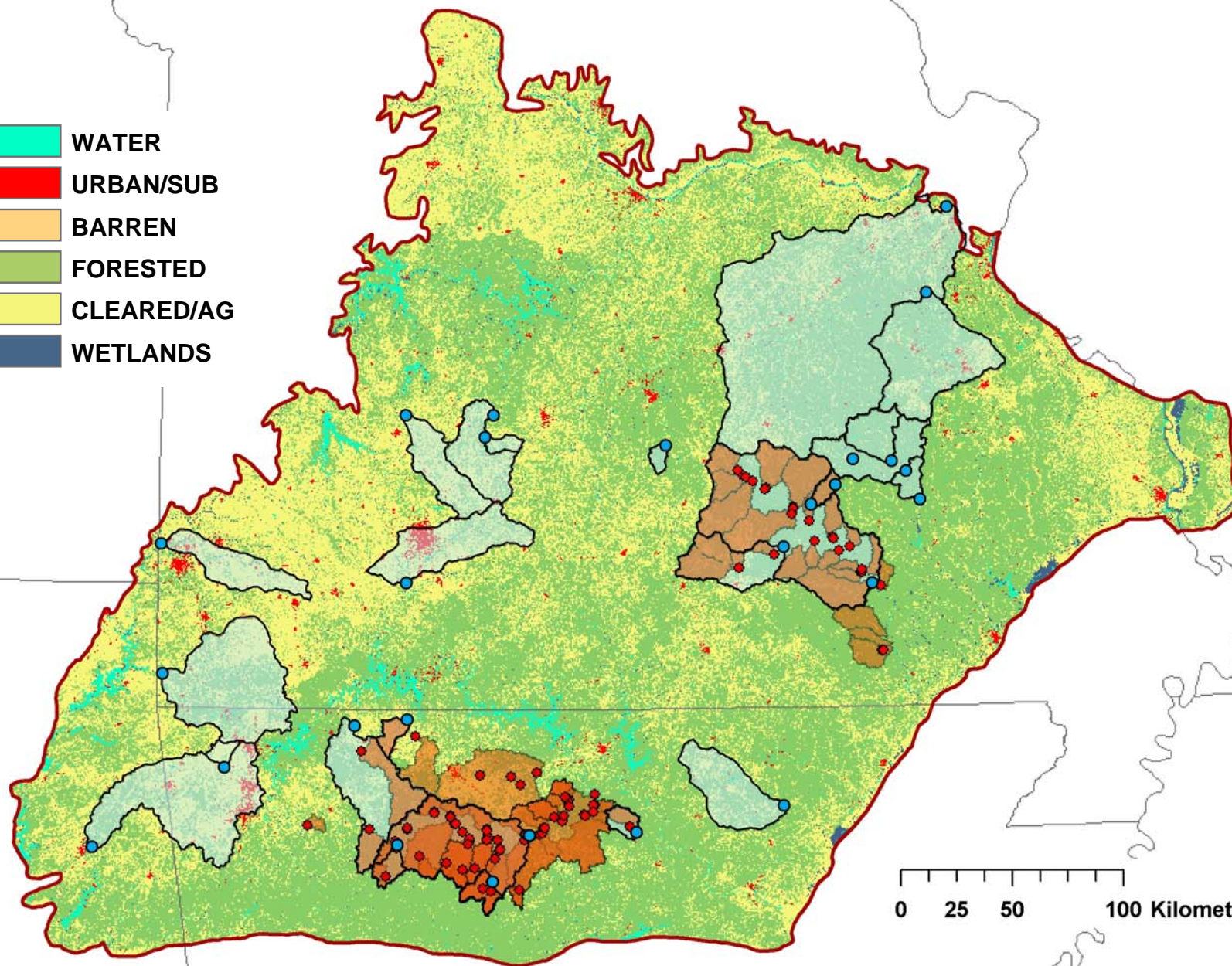
Architecture of the Missouri National Recreation River

Discrete and persistent, broad and narrow reaches

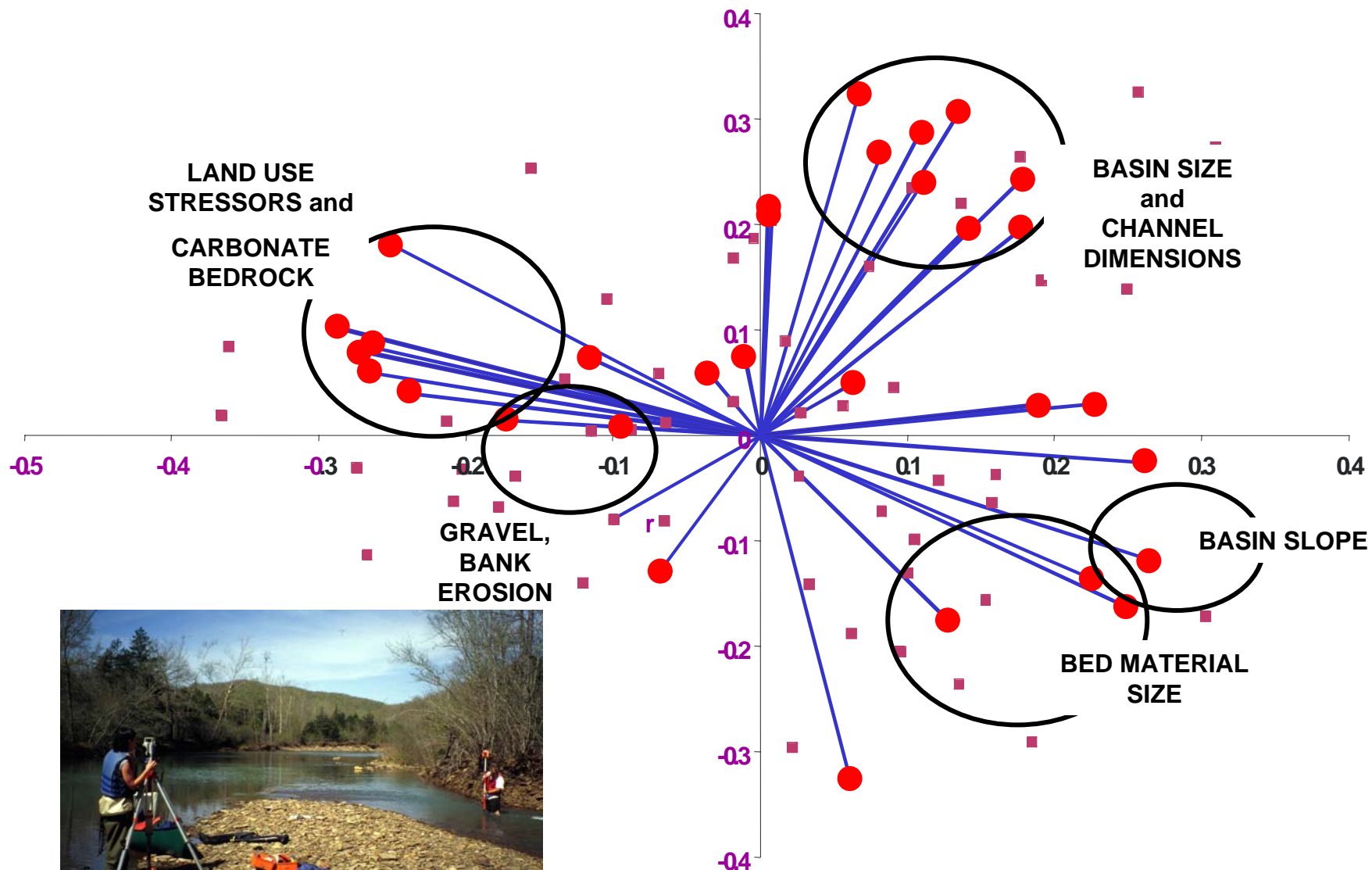


Space

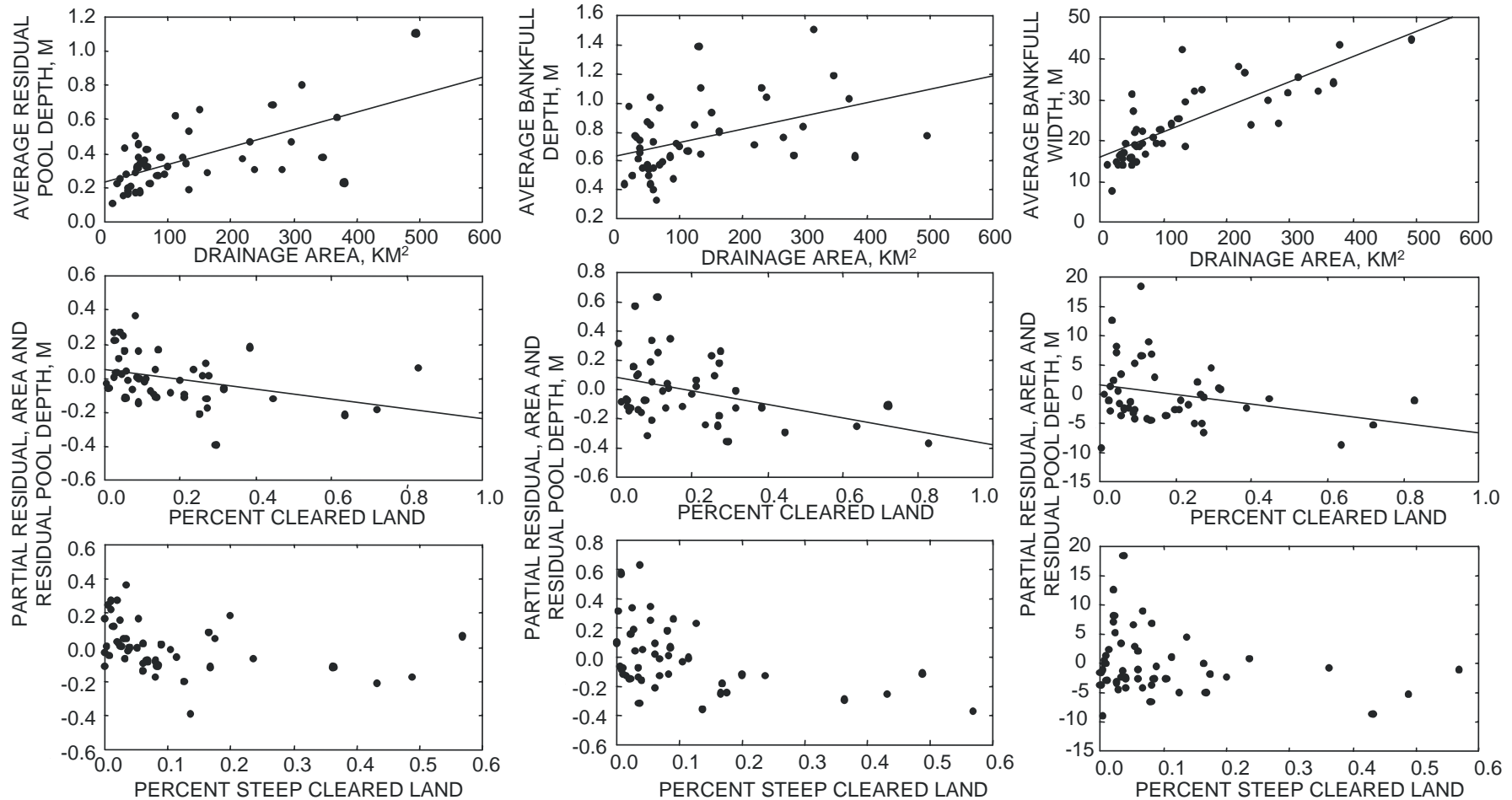
- **Work:** Does land use outside of park boundary affect park aquatic resources?
- **Play:** Propagation of disturbances through watersheds, cumulative/complex responses



Principal Components Analysis: Basin and Reach Scale



No Smoking Gun



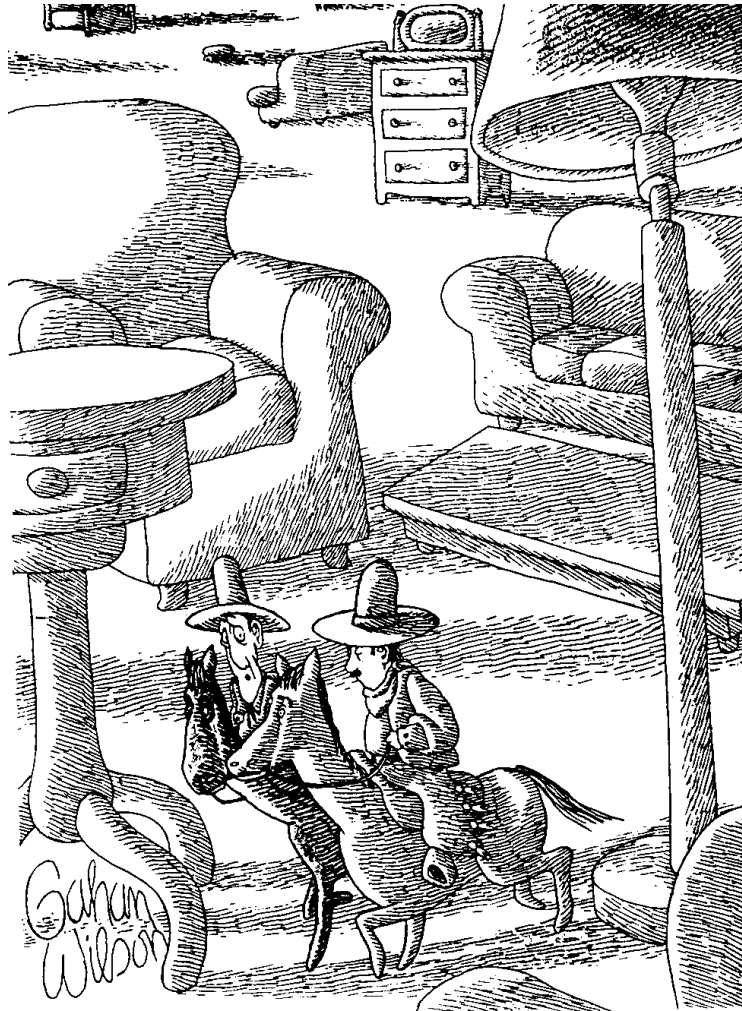
Time

- **Work:** *To what extent is the park subject to future disturbances, ongoing effects of past disturbances?*
- **Play:** *Propagation of disturbances through watersheds, cumulative/complex responses, sediment routing*

Observation: Ozarks streams are characterized by large accumulations of chert gravel, manifest instability.



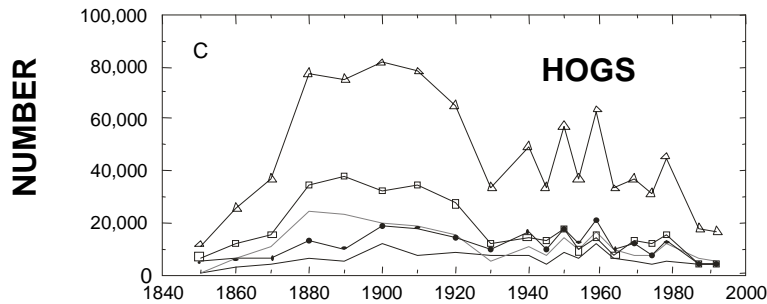
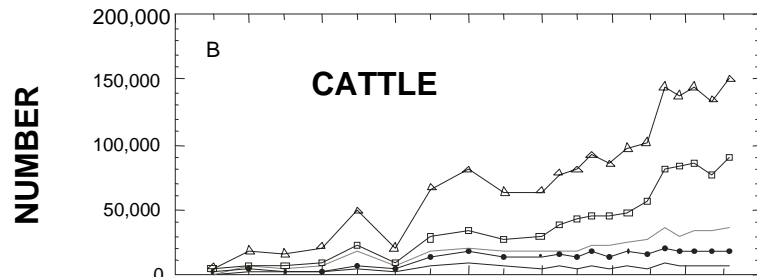
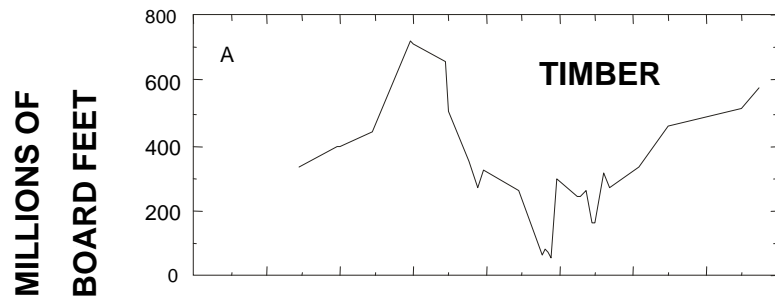
Natural or Human-induced Change?



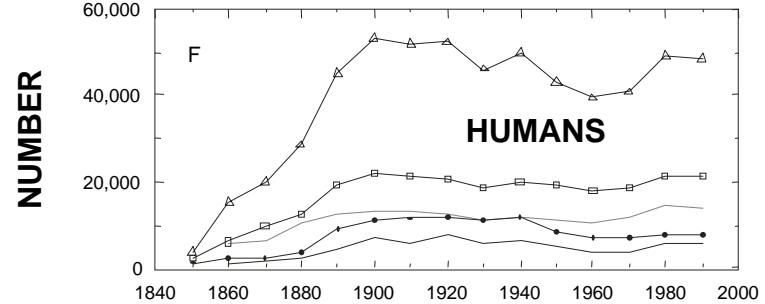
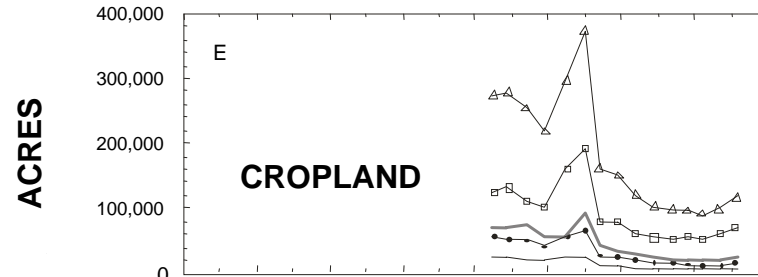
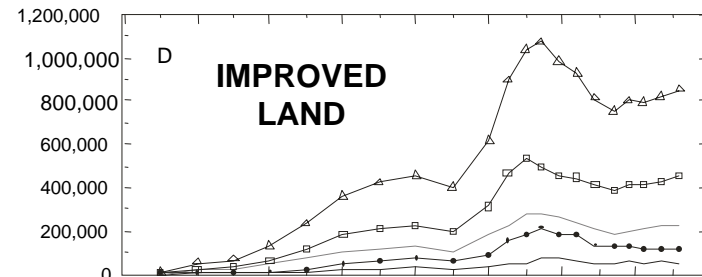
*"It's hard to believe that all this
was created by natural erosion!"*

Missouri Ozarks Land-Use History

Plenty of potential stress, complex interactions



COUNTIES: — CARTER — DENT



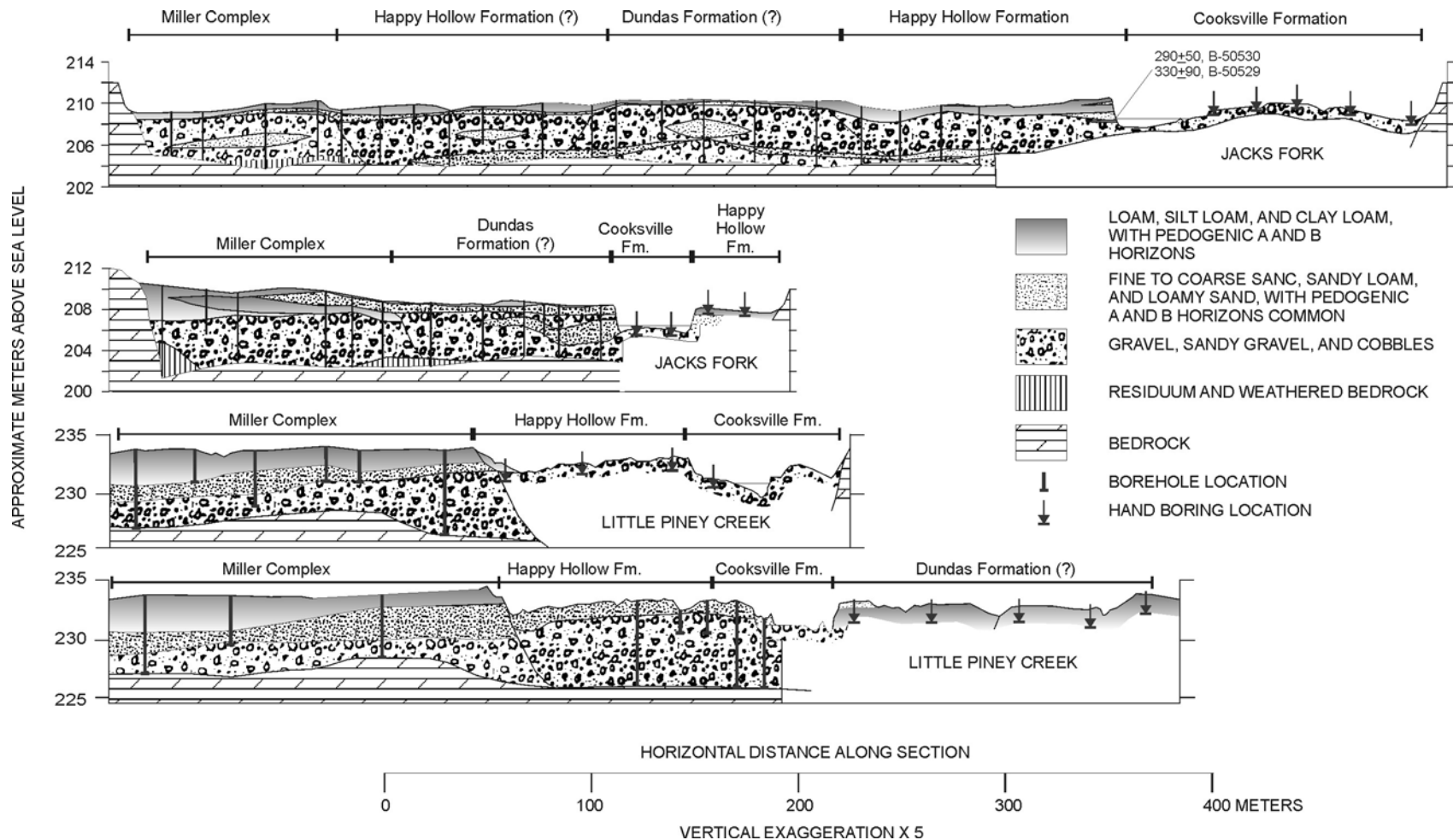
—•— SHANNON —□— TEXAS —△— TOTAL

Historical Data on Land-use History

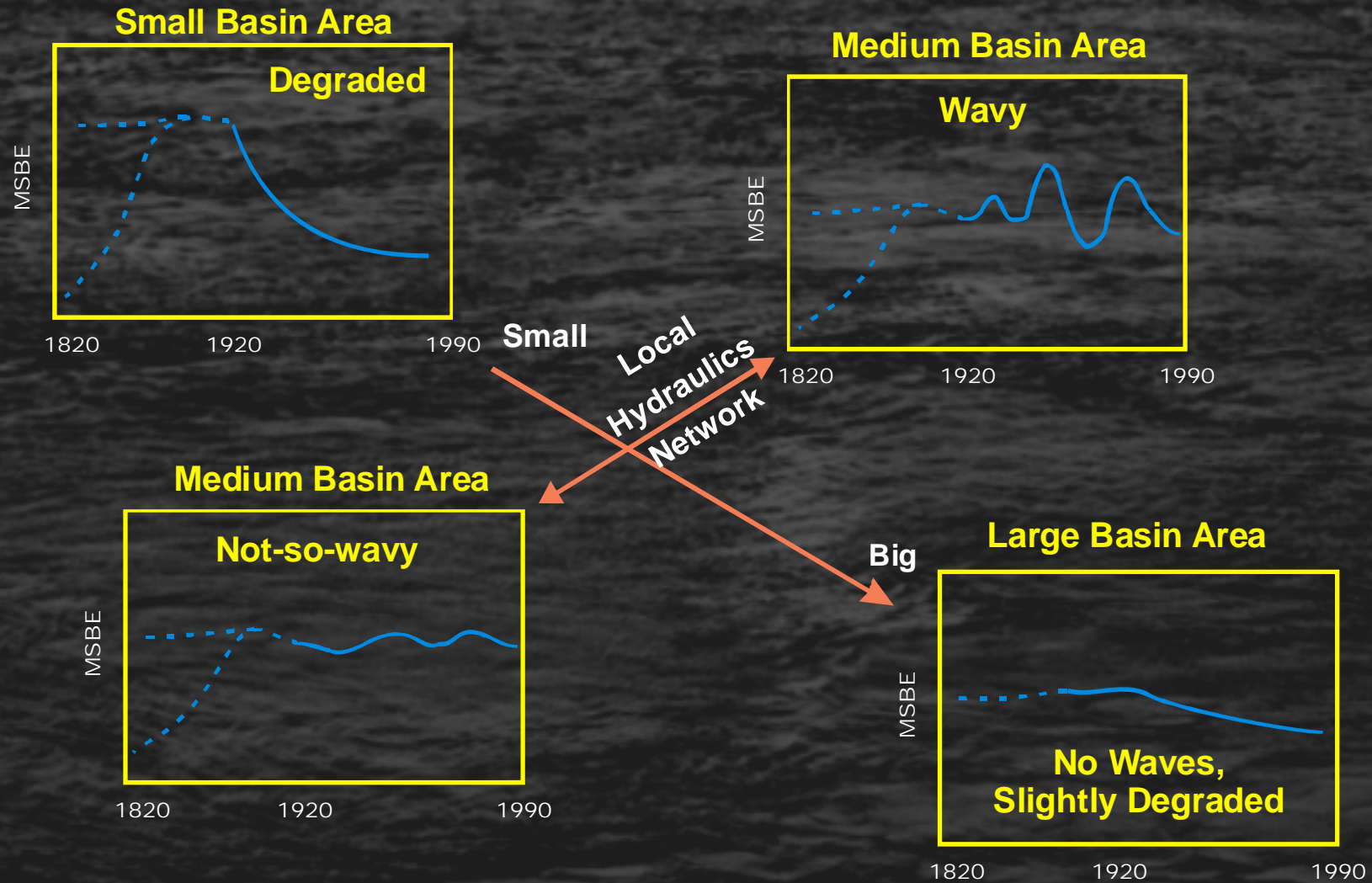


Alluvial Stratigraphic History

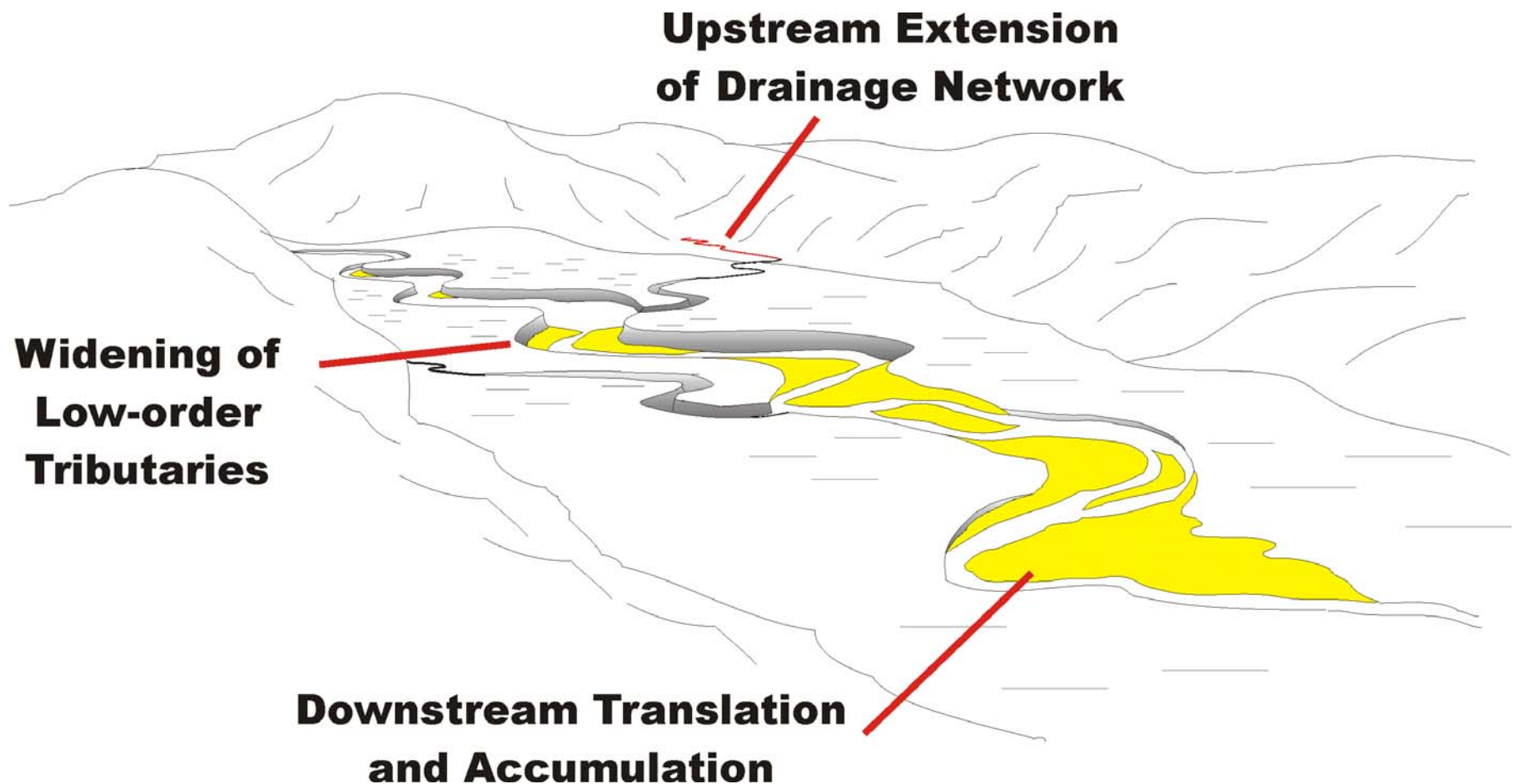
Recent increase in gravel deposition, in rivers that have always been gravel-rich



Streambed Elevations Indicate Sediment Waves



Historical Disturbance and Sediment Routing

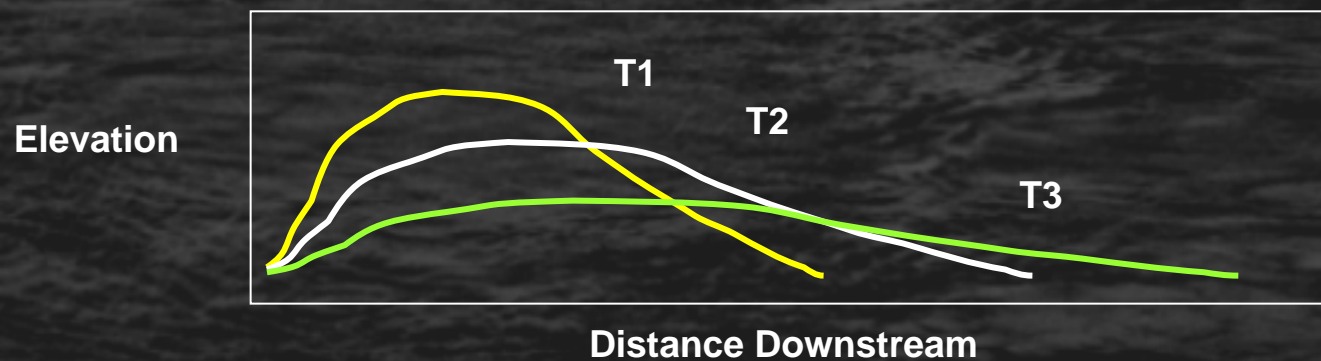


Sediment Routing Theory: Translation or Dispersion?

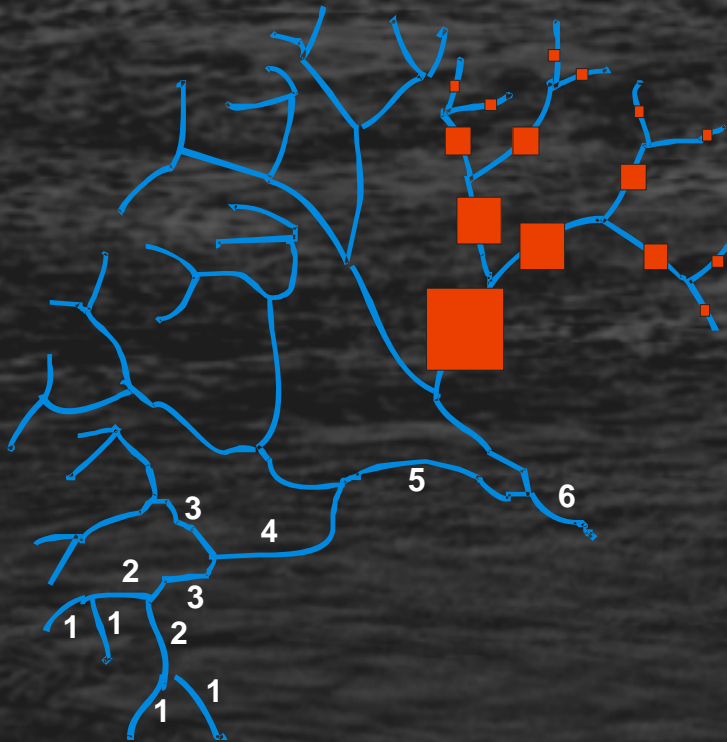
Translation



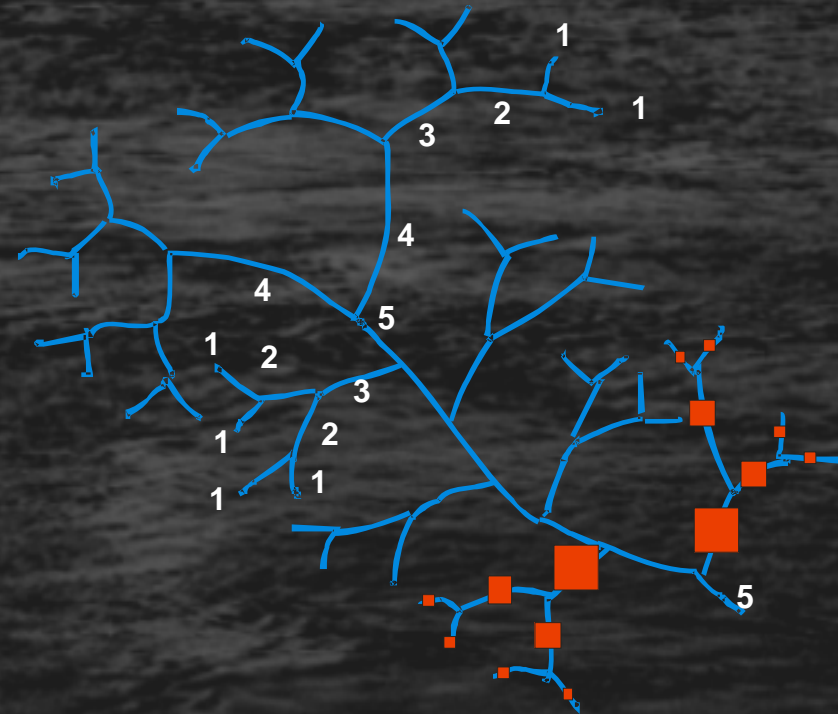
Dispersion/diffusion



Channel-network Controls on Sediment Routing

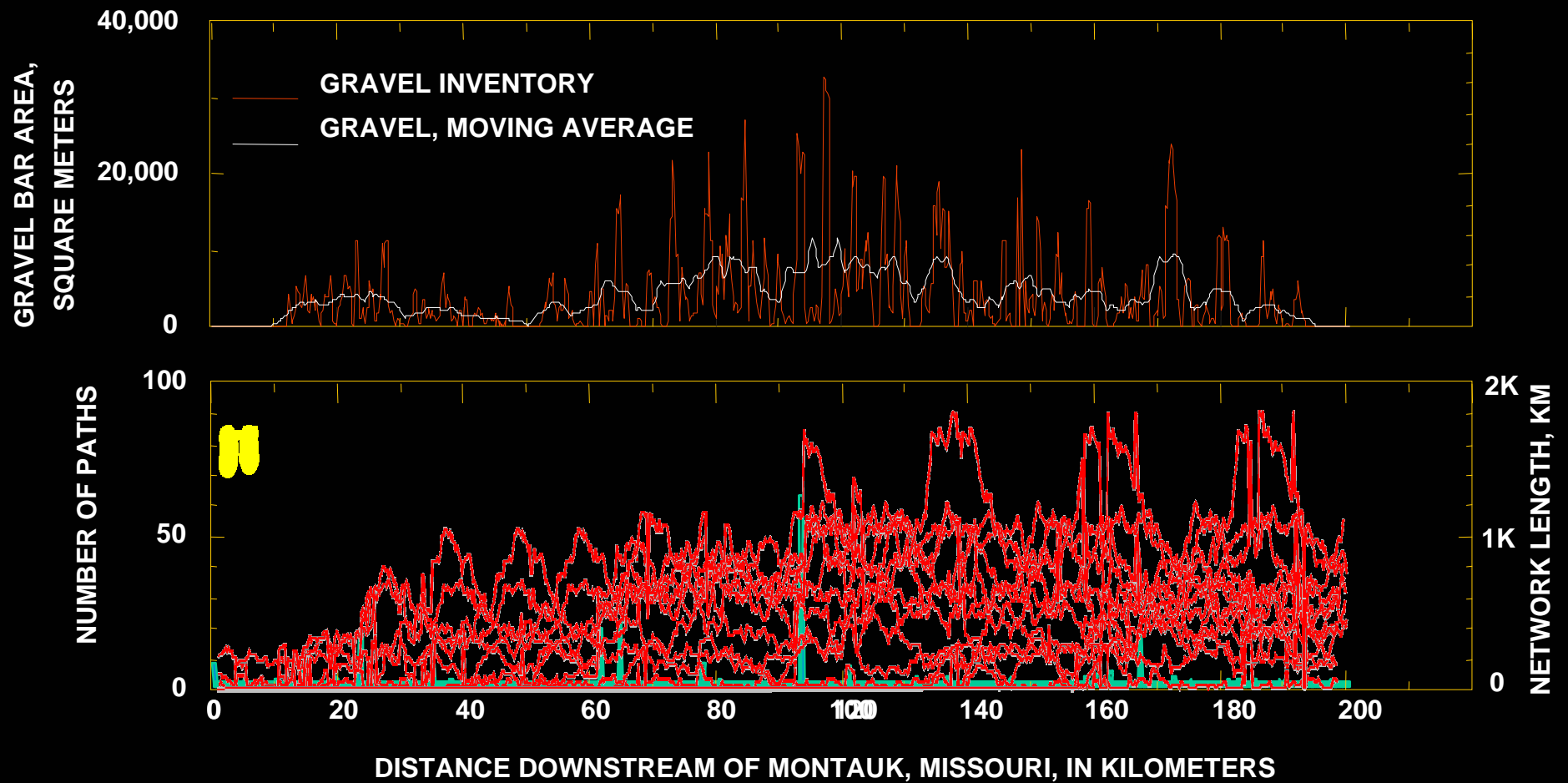


DENDRITIC BASIN
Maximum waves

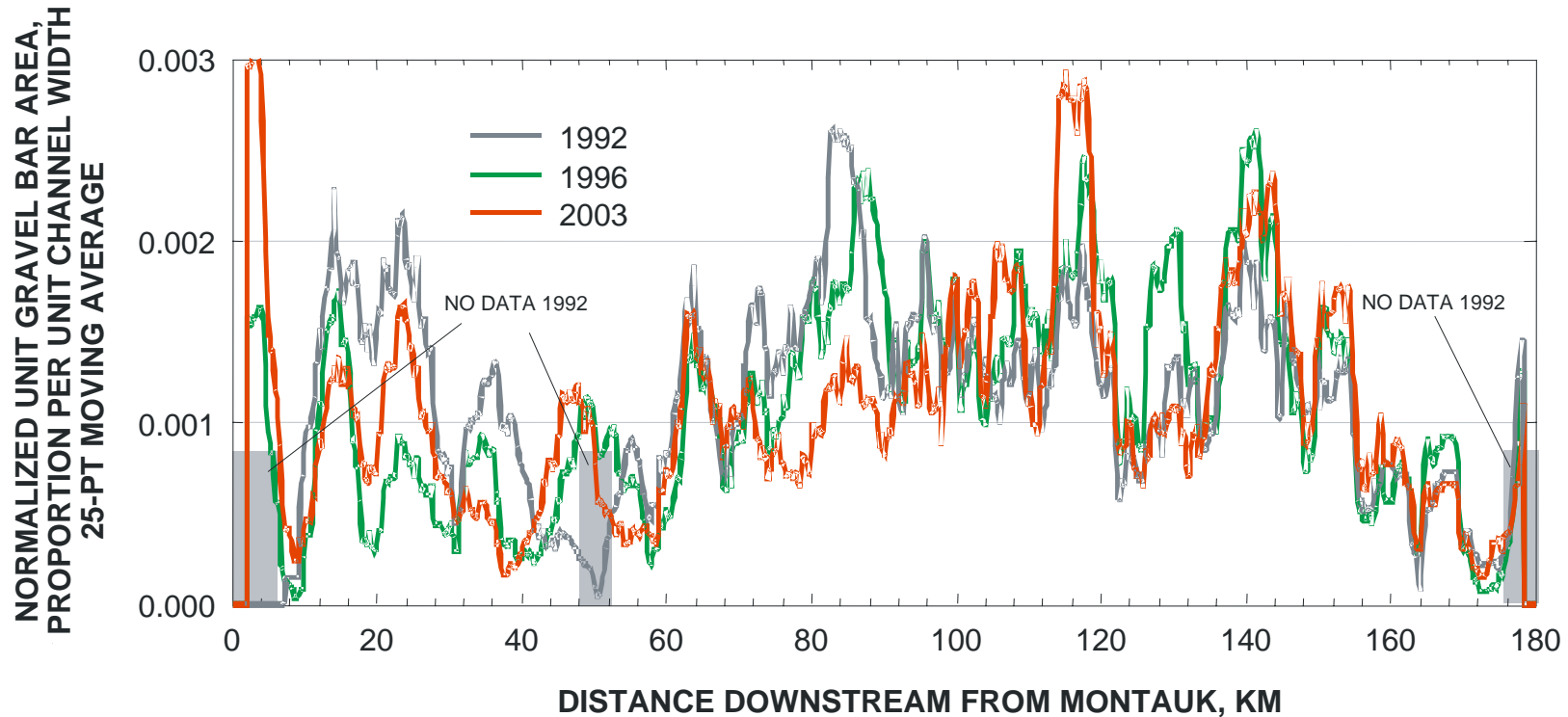


TRELLIS-SHAPED BASIN
Minimum waves

Gravel Distribution and Simple Routing Model



Gravel Distribution 1992, 1996, and 2003



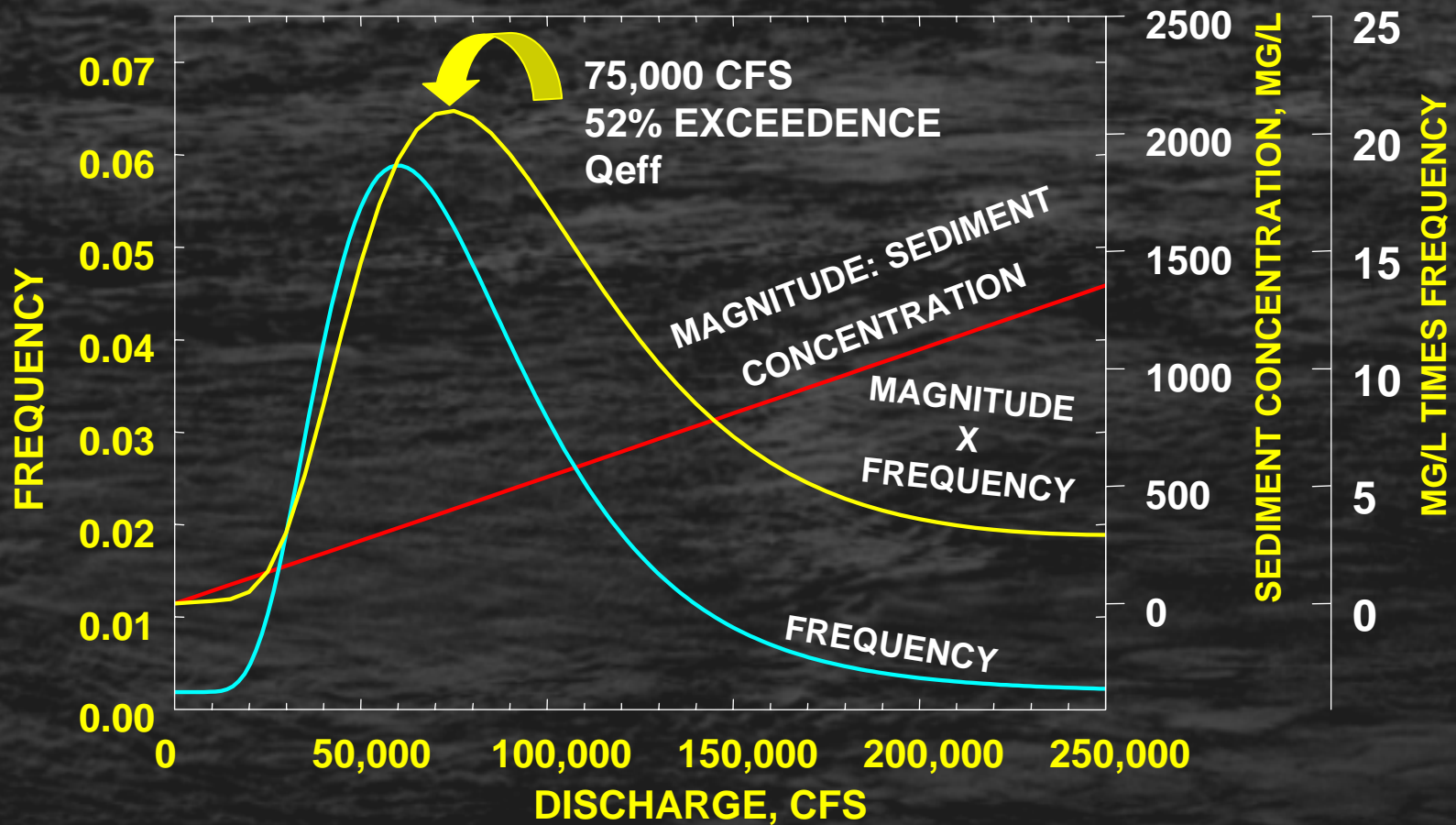
- Rate of movement, center of mass:
 - Using 50-year flood, 1993: 100 m y^{-1}
 - Using 11 years (2003-1992): 320 m y^{-1}
- Rate of movement, particles:
 - Historical match to model: $200 - 1100 \text{ m y}^{-1}$

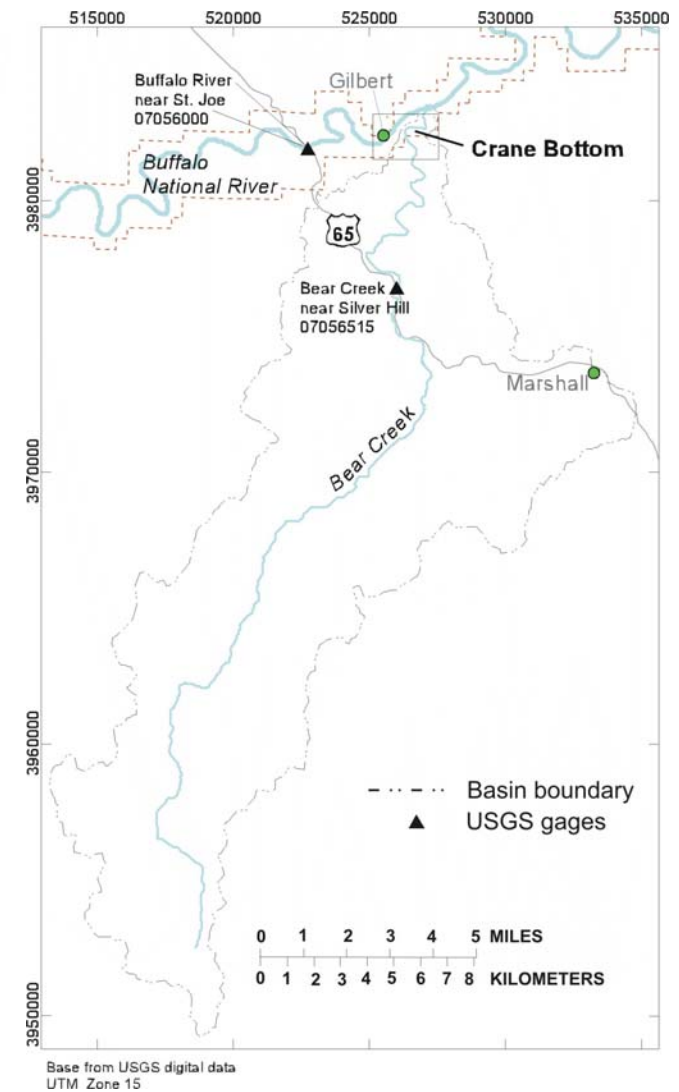
Time

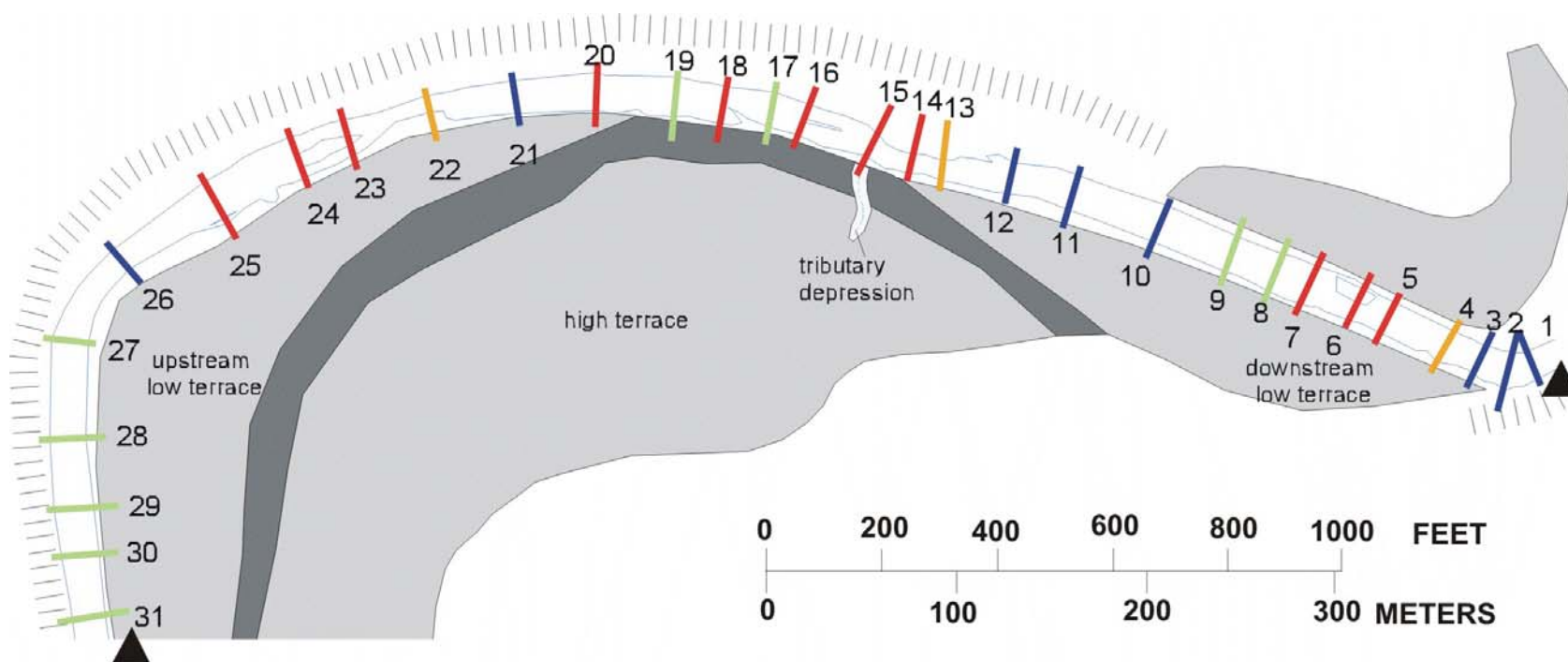
- ***Work:** What are implications of hydrologic regulation for habitat availability in a park?*
- ***Play:** Explore the magnitude and frequency of geomorphic and ecologic processes.*

Effective Discharge Calculations

Sediment Transport of Missouri River at Hermann, Missouri











EXPLANATION

-  Terrace
-  Terrace scarp
-  National Park Service stage gages

-  Bluff or very steep slope
-  Edge of water (December survey)

- Cross sections by dominant habitat type
-  Glide
 -  Pool
 -  Race
 -  Riffle

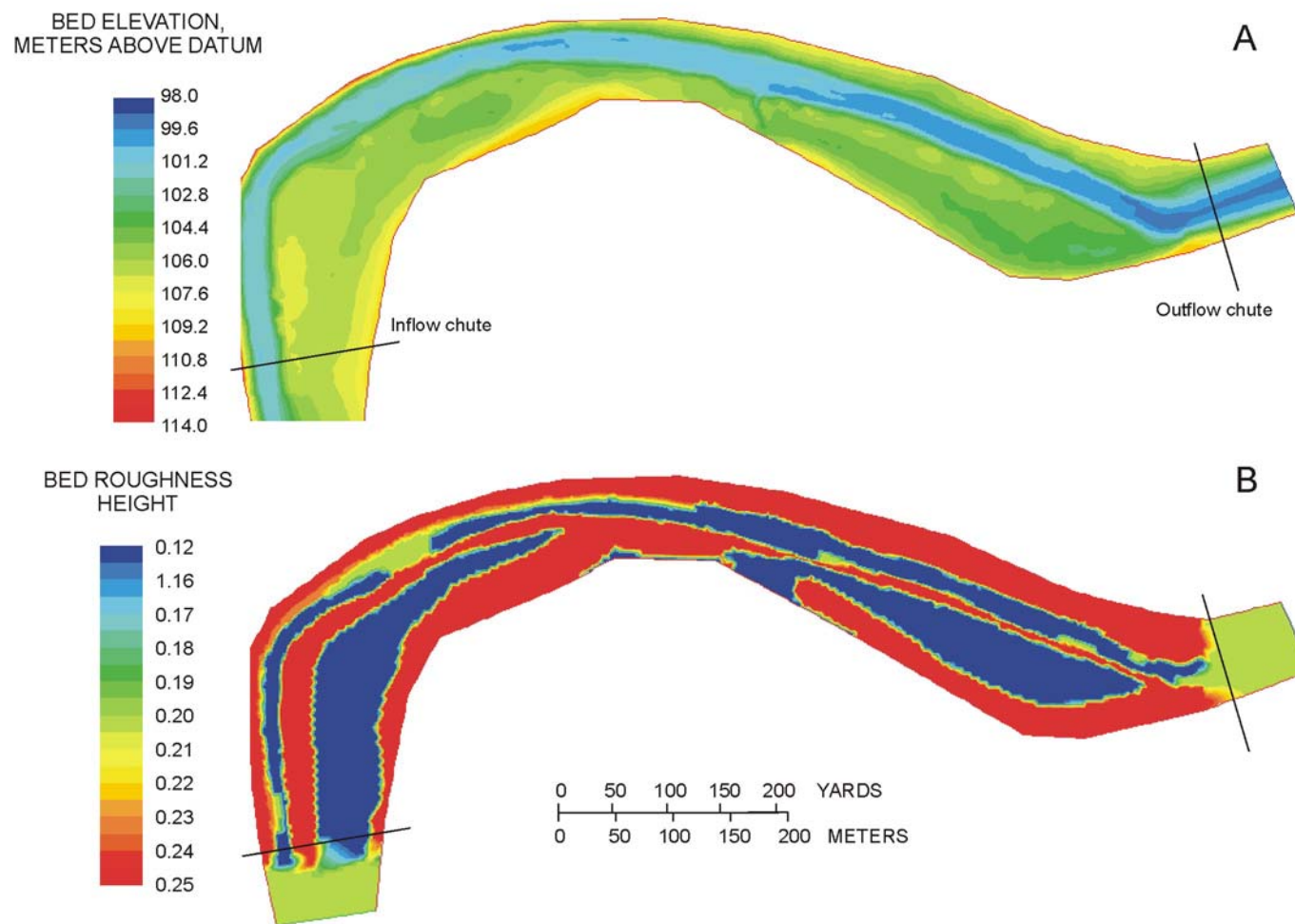
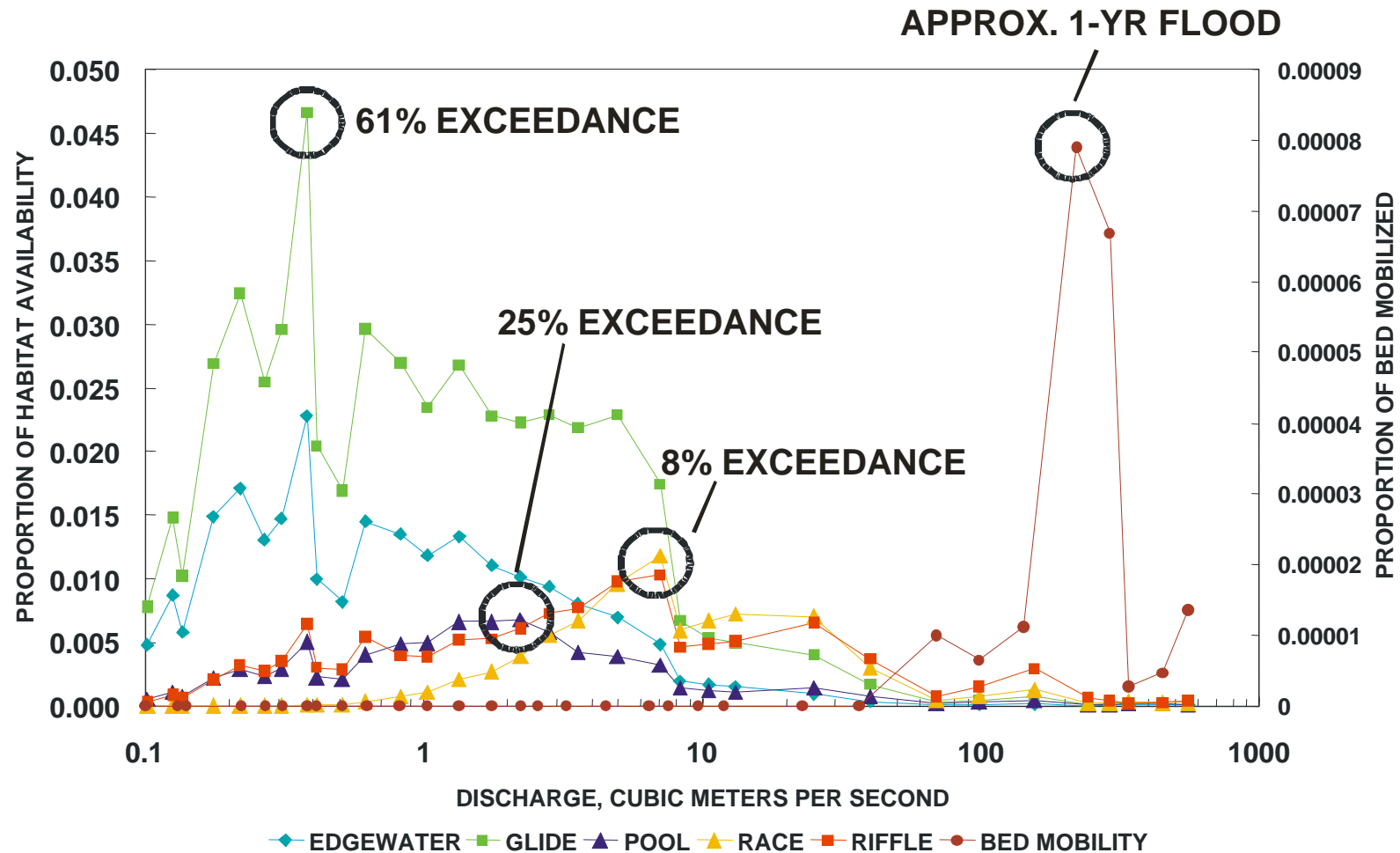


Figure 23. Model input data grids for Crane Bottom. The input map grids were used to parameterize the finite element mesh bed file. A. Elevation grid. B. Bed roughness height (k_s) grid.

Effective Discharge for Habitat Availability and Bed Mobilization



Play Applied to Science and Management

- **Parallel Play**
 - **Multidisciplinary: playing in the same sandbox without interacting across disciplines**
- **Group Play**
 - **Interdisciplinary, transdisciplinary: playing in the sandbox without boundaries to address complex environmental problems with holistic understanding**

INTERDISCIPLINARY STUDIES

	Room
CHEMISTRY FOR GEOLOGISTS	127
MATH FOR ARCHEOLOGISTS	214
PHYSICS FOR PSYCHOLOGISTS	206
BIOLOGY FOR MATHEMATICIANS	319
GEOLOGY FOR ENTOMOLOGISTS	114
BOTANY FOR ASTRONOMERS	
ANATOMY FOR PHYSICISTS	
PSYCHOLOGY FOR LABORATORIANS	
ANTHROPOLOGY FOR CHEMISTS	
TOPOLOGY FOR PALEONTOLOGISTS	
NUCLEAR PHYSICS	



Play Applied to Science and Management

- *Complex science issues require scientists to play well with each other, to see the world through other's eyes.*
- *Difficult management questions require that scientists play well with managers.*
- *Adaptive management, stakeholder driven management requires that scientists play well with the public.*



Geomorphologists at Play, Geomorphologists at Work

- *Geomorphology works for many aspects of resource management – integrated disciplines, right time, & right space.*
- *Geomorphic work is never far from geomorphic play. Even the most applied geomorphology project is closely tied to fundamental theoretical issues – field studies almost always provide surprises -- parks provide great opportunities to play!*
- *Playing together is essential. Scientists must play well among themselves, with managers, and with the public.*

